

Development and Validation of a Physics-Based Model for Deployable Hypersonic Decelerator Flexible Thermal Protection Systems

Completed Technology Project (2012 - 2016)



Project Introduction

Over the years, the main focus of Entry, Descent, and Landing (EDL) research and development has been missions to the surface of Earth and Mars, with a few exceptions. In the past two decades, the fundamental Viking entry vehicle design has been incrementally improved to increase landing mass capability. Landing additional mass beyond MSL capability has proved difficult in recent years. NASA must start an ambitious testing program to develop Thermal Protection System (TPS) material effectiveness for Deployable Hypersonic Decelerators (DHDs) as a means to dramatically increase mission capabilities. NASA has increased the knowledge base for Non-Ablative Flexible TPS (NAFTPS) materials through the Hypersonic Inflatable Aerodynamic Decelerator (HIAD) Technology Development (HIAD TD) Program. This research proposes to significantly extend the HIAD TD Flexible Systems Development (FSD) plan and improve thermal material response modeling capabilities by creating a Physics-Based Model (PBM) to accurately represent convection and radiation for Non-Ablative Flexible TPS (NAFTPS) materials during atmospheric entry. Rigorous ground-based testing will provide validation and verification capabilities for this computer based, transient heat-transfer model. The PBM will combine many entry physics models together into one simultaneous analysis using an engineering program called COMSOL. The proper governing equations representing the aerothermodynamic environment and the thermal material response behavior during entry will be extracted from Computational Fluid Dynamics (CFD) tools and inputted into the COMSOL framework. The end product will be an accurate 3-dimensional NAFTPS material response simulation that matches experimental data and can be extrapolated outside of ground testing conditions. The research approach will utilize HIAD TDs predefined NAFTPS material coupon layout and testing schedule while suggesting a few additional experimental facilities. Once validated against experimental data, the PBM will provide more accurate NAFTPS mass estimations which allow for either reduced mass margin or increased payload capability.

Anticipated Benefits

Landing additional mass beyond MSL capability has proved difficult in recent years. NASA must start an ambitious testing program to develop Thermal Protection System (TPS) material effectiveness for Deployable Hypersonic Decelerators (DHDs) as a means to dramatically increase mission capabilities. NASA has increased the knowledge base for Non-Ablative Flexible TPS (NAFTPS) materials through the Hypersonic Inflatable Aerodynamic Decelerator (HIAD) Technology Development (HIAD TD) Program. This project aims to significantly extend the HIAD TD Flexible Systems Development (FSD) plan and improve thermal material response modeling capabilities by creating a Physics-Based Model (PBM) to accurately represent convection and radiation for Non-Ablative Flexible TPS (NAFTPS) materials during atmospheric entry.



Project Image Development and Validation of a Physics-Based Model for Deployable Hypersonic Decelerator Flexible Thermal Protection Systems

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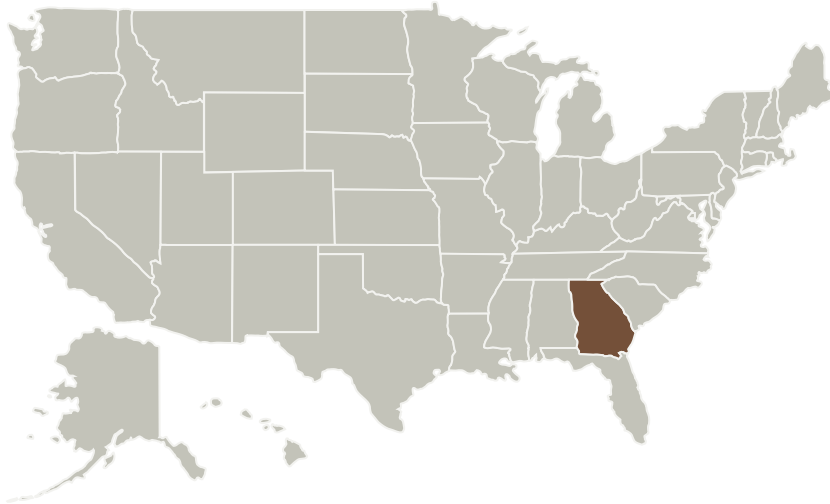
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Georgia Institute of Technology-Main Campus(GA Tech)	Supporting Organization	Academia	Atlanta, Georgia

Primary U.S. Work Locations

Georgia

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

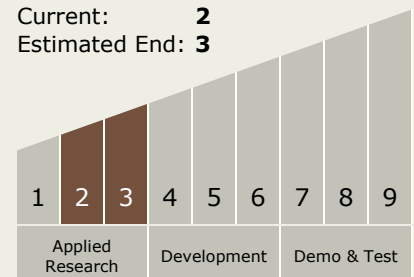
Robert D Braun

Co-Investigator:

Grant A Rossman

Technology Maturity (TRL)

Start: 2
Current: 2
Estimated End: 3



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Images



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Project Image Development and Validation of a Physics-Based Model for Deployable Hypersonic Decelerator Flexible Thermal Protection Systems

(<https://techport.nasa.gov/image/1746>)

Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
 - └ TX09.4 Vehicle Systems
 - └ TX09.4.5 Modeling and Simulation for EDL